This document is guaranteed to be current only to issue date.

Some Mars Global Surveyor documents that relate to flight operations are under revision to accommodate the recently modified mission plan.

Documents that describe the attributes of the MGS spacecraft are generally up-to-date.

542-409, Volume 6, Part 2

Mars Global Surveyor

Mission Operations Specifications

Volume 6: Test Plan

Part 2: Flight Sequence Verification and Validation

Final

March 21, 1996

Jet Propulsion Laboratory
California Institute of Technology

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MARS GLOBAL SURVEYOR

MISSION OPERATIONS SPECIFICATION

Volume 6
Part 2

Flight Sequence Verification and Validation Plan

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TABLE OF CONTENTS

SECTION I

INTRODUCTION

1.1 IDENTIFICATION

The Mars Global Surveyor Flight Sequence Verification and Validation Plan, 542-409, Volume 6, Part 2 documents the plan to be used to verify and validate Mars Global Surveyor flight sequences before they are uplinked to the spacecraft.

Verification and Validation (V&V), as applied here, are defined as follows:

> Verification: The process of determining that the sequence end products (Predicted Events Files and Spacecraft Message Files) are correct with respect to each other, the source Spacecraft Activity Sequence Files, the Command Dictionary, and the Block Dictionary expansion definitions.
>
> Validation: The process of determining that the sequence loads correctly, the consistency of the spacecraft and System Test Laboratory (STL) telemetry products with respect to flight sequence commands.

Sequence verification will be performed by the Flight Team by analysis of the products from the sequencing software and by using the reverse translator REVTRAN. Sequence validation is performed by the Flight Team using the products from the sequencing software and from STL.

1.2 PURPOSE

The purpose of this document is to 1) establish a Flight Sequence V&V plan and to 2) identify required Flight Sequence V&V inter-team and supporting organization Operational Interface Agreements (OIA's).

1.3 SCOPE

This document describes the method with which all Mars Global Surveyor flight sequences are to be verified and validated.

1.4 OBJECTIVE

Flight Sequence Verification and Validation testing is used to assure the Mars Global Surveyor project that:

- Sequences have been correctly assembled
- Sequences contain valid command blocks/commands

- Sequences will correctly load on the spacecraft
- Sequences will effect the desired action by the spacecraft systems
- Command cause and effect are correctly modeled

Flight Sequence Verification and Validation will satisfy the requirements set forth in paragraph 3.3.8.3 of the Mission Requirements Document, 542-400, which states as follows:

> The MOS shall ensure that all sequences developed and transmitted to the spacecraft do not violate the rules defined in the Flight and Mission Rules document and meet the mission objectives as implemented in the Mission Sequence Plan.
>
> The MOS shall define sequence validation criteria and all flight sequences meeting the criteria shall be tested with the Spacecraft Test Laboratory (STL), before uplink to the spacecraft.
>
> Project identified mission critical sequences shall be tested with the spacecraft and the STL prior to launch.
>
> Note that science non-interactive commands, defined as those commands which are routed directly to the PDS and do not affect spacecraft resources (e.g., power, propellant, CDS stored sequence memory, etc.), are not constrained by this requirement.

1.5 APPROACH

When building a sequence, SEQ generates two sequence end products, a Predicted Events File (PEF) and a Spacecraft Message File (SCMF). The SCMF is reverse translated to yield a REVTRAN Predicted Events File (RPEF) which can be compared directly to the PEF to detect sequence translation errors. If discrepancies are found, the software error can be corrected and the files regenerated and compared again until a clean compare occurs.

The STL executes flight sequences (or portions thereof) and confirms successful operation of the sequence execution. The SCT reviews the sequence review products which include all expected blocks/commands that were executed. Engineering Data Format (EDF) telemetry is passed to the SCT via the Test, Telemetry and Command System (TTACS).

SCT reviews the telemetry data to validate the correct correlation between command/telemetry pairs and the fidelity of the STL/spacecraft models. SCT establishes that the STL spacecraft simulation functioned as intended by the sequence.

The SEQ Team Chief and Spacecraft Team Chief or their designates certify the sequence using the Automated Command Tracker (ACT). A sequence is considered "Certified" by the project when all required signatories have approved the sequence using the ACT.

The overall test philosophy is that critical activities will be tested as opposed to testing complete sequences. Specific guidelines for determining these sequence tests are as follows:

- All blocks shall be tested at least once
- Groups of overlapping blocks shall be tested
- All maneuvers shall be tested (only 3 OTM types)
- All planned interactive non-stored commands shall be tested
- All deployments shall be tested
- Noncritical repetitive activities shall be tested upon first usage only.
- Time jumps will be used to skip over sequence dead time and activities not being tested
- All flight software changes shall be tested, including one typical block or sequence which exercises the software change
- All block changes which have flight software or fault protection interactions shall be tested
- All Block changes which reorder commands within a Block shall be tested
- All Fault Protection changes involving logic, critical parameters or strategy shall be tested
- All non-stored commands which could potentially interact with fault protection or the stored sequence shall be tested

For all sequence tests, the entire SCMF will be loaded into the STL to ensure correct loading, but only the selected portions will be executed. Spacecraft configuration will be maintained by uplinking all required command loads whether testing is required or not.

1.6 APPLICABLE DOCUMENTS

The following reference documents provide information closely related to the subject of this document or are the source of requirements. In the event of conflicting sources, Mars Global Surveyor documents take precedence.

The FS V&V plan is consistent with and is responsive to controlling requirements in the following Mars Global Surveyor documents:

1.	542-400	Mars Global Surveyor Project Mission Requirements Document; JPL D-2940
2.	542-401	Mars Global Surveyor Project Mission Plan; JPL D-2518

3.	542-407	Mars Global Surveyor Project Mission Sequence Plan; JPL D-3826
4.	542-409, Vol. 1	Mars Global Surveyor Operations Specification: System; JPL D-3721
5.	542-409, Vol. 2	Mars Global Surveyor Operations Specification: Data System; JPL D-3721
6.	542-409, Vol. 3	Mars Global Surveyor Operations Specification: Operations; JPL D-3721
7.	542-417	Mission Operations System Office Facility and Operations Plan; JPL D-5675
8.	542-416	Mission Operations System Office Support Plan; JPL D-6211

SECTION II

VERIFICATION AND VALIDATION PLAN

2.1 INTRODUCTION

The Mission Planner designs the flight sequences and documents them in the Mission Sequence Plan (MSP) in the form of event timelines. For certain critical sequences a skeleton SASF shall be provided. The Sequence Team (SEQ) develops a Spacecraft Activity Sequence File (SASF) for each flight sequence from this design. Using the sequencing software, the SEQ generates a Predicted Events File (PEF), a Spacecraft Message File (SCMF) and a predict Sequence of Events (SOE). Then using REVTRAN, the reverse translator, the SCMF is translated back into a REVTRAN Predicted Events File (RPEF) and is compared against the PEF file. The SEQ then places the sequence products on the PDB for Flight Team review of the sequence and notifies the flight team of a sequence's readiness using the ACT. The sequences shall then be extracted from the PDB by the SCT, loaded into the STL and executed in accordance with all appropriate SCT procedures

2.2 SEQUENCE VALIDATION

Flight Sequence Validation will be performed using the STL. The STL will be operated by the SCT and the results will be analyzed by the SCT.

The SCMF and the SOE are transferred from the PDB to the STL host for sequence simulation.

After a sequence is loaded in the STL script buffer, a memory dump of the script buffer will be generated. This file will be compared to the initial buffer contents predicted by SEQTRAN. The objective of this comparison is to verify that the sequence memory load has been performed correctly.

When the sequence load has been confirmed to be correct, the sequence will be executed on the STL. Objectives of this test are to validate that those portions of a sequence requiring simulation (1) execute the proper and predicted commands and (2) satisfy the desired intent of the sequence.

The STL data will be analyzed to identify any errors that occur. When errors are found, the nature of each error and its source will be identified and documented per appropriate SCT procedures and use of the project's electronic anomaly reporting system.

The results of each sequence execution will determine whether the V&V objectives as stated in section 1.4 of this document have been met. If the determination of the problem resolution process is that the sequence is in error, sequence regeneration and

reverification/revalidation will be performed. The disposition of problems determined not to be sequence errors will be in accordance with appropriate flight team procedures.

2.3 GROUND DATA SYSTEM SUPPORT

The MGS GDS elements employed for Flight Sequence V&V are as defined in MGS MOS Specification, Volume 2: Data System.

2.4 MISSION OPERATIONS SYSTEM OVERVIEW

The FS V&V requires the following project and MGSO resources:

- Mission Planner
- Sequencing Team (SEQ)
- Spacecraft Team (SCT)

2.5 PROBLEM/ANOMALY REPORTING

Errors encountered in the following areas shall be documented in accordance with appropriate flight team procedures and by using the project's electronic anomaly reporting system.

- Hardware
- Software (including FSW)
- Sequences
- Operational Procedures
- Documentation

2.6 DATA PRODUCTS

The following data products will be provided during FS V&V.

- Sequence Design Files
  - Mission Sequence Plan Sequence Event Timelines

- Sequence Files
  - SEQGEN Spacecraft Activity Sequence File (SASF)
  - SEQGEN Predicted Events File (PEF)
  - SEQTRAN Spacecraft Message File (SCMF)
  - Sequence of Events File (SOE)

- Spacecraft Team Products
  - STL Test Criteria
  - Star Catalog / Ephemeris Table Loads
  - Sequence Initial Conditions for STL (when required)

SCP I/O Log (SIL) - STL Product
Memory Dumps (MEMDMP) - STL Product
Non-realtime EDF Telemetry File (via TTACS) - STL Product
Realtime EDF Telemetry Stream (via TTACS) - STL Product